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Kunz et al.

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(54) **OUTLET BOX FOR POWER TOOL SENSE**

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A47L 9/00 (2006.01)

(52) **U.S. Cl.**
USPC **15/339**; 15/314; 15/319

(58) **Field of Classification Search**
USPC 15/314, 319, 339
See application file for complete search history.

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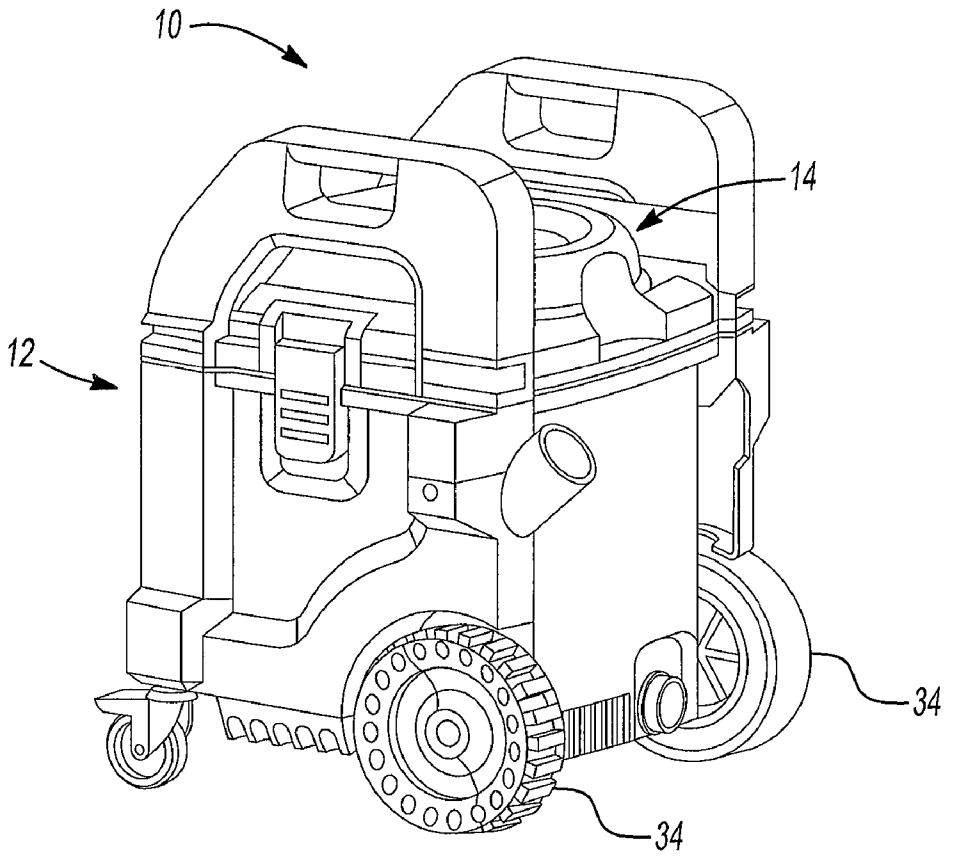
(57) **ABSTRACT**

A vacuum electronic power tool sense system senses the operation of a power tool that is plugged into an auxiliary outlet box and the vacuum source is automatically operated to facilitate user clean-up of debris generated by use of the power tool. The auxiliary outlet box can be removably mounted to the vacuum housing.

5 Claims, 8 Drawing Sheets



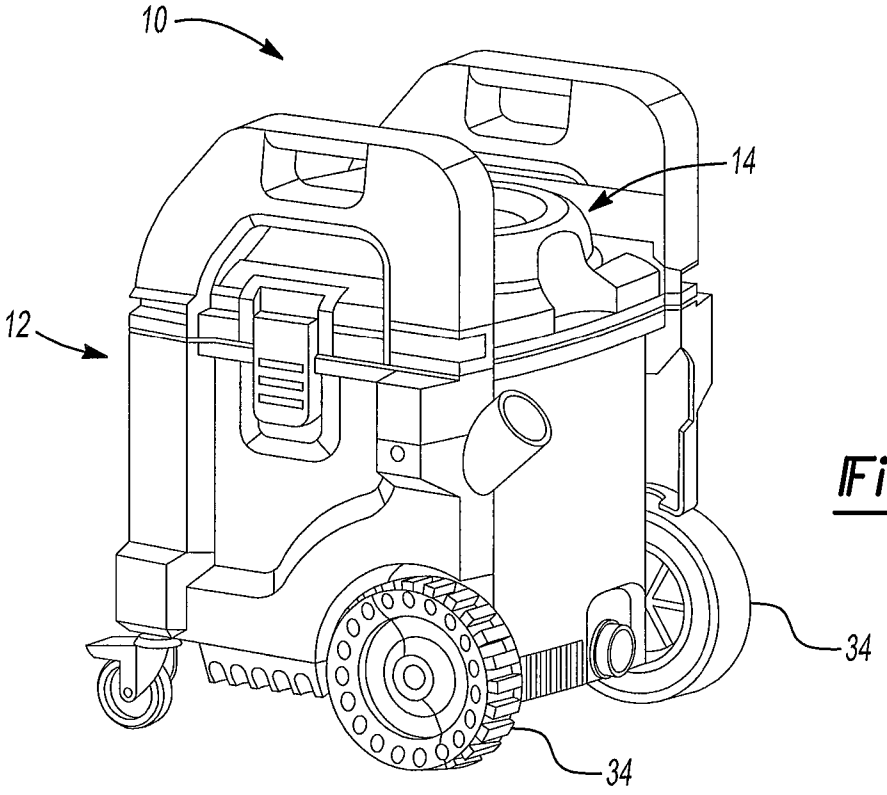


Fig-1

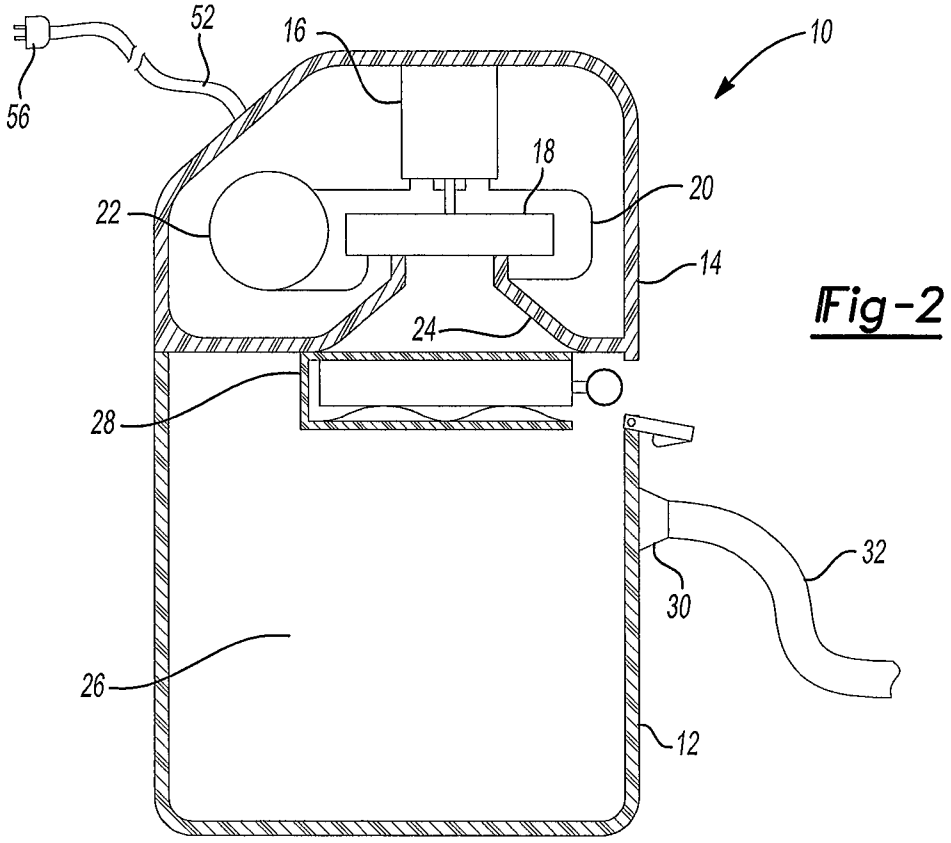
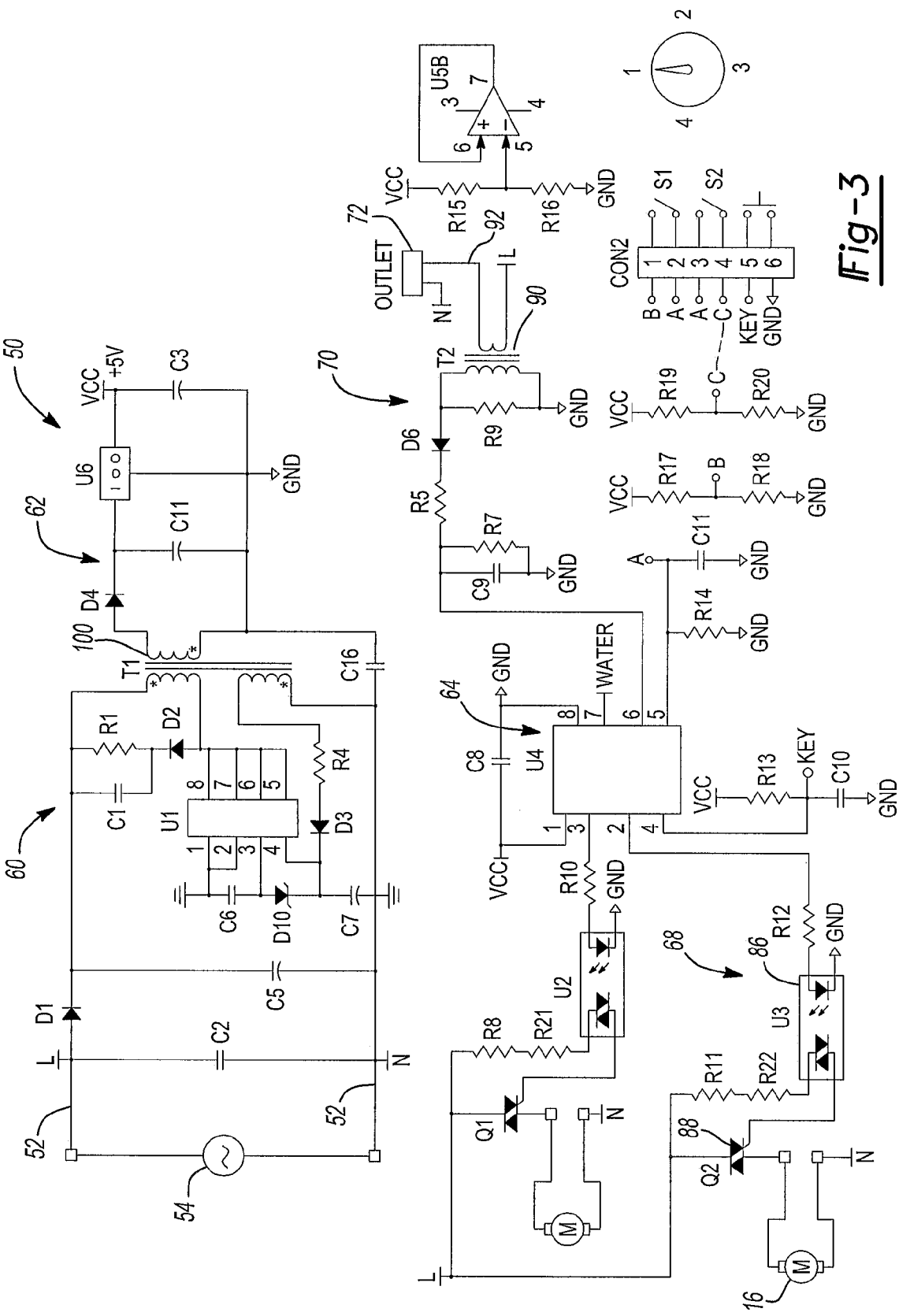


Fig-2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VCC
+5V
C3
U6
GND
62
C11
D4
100
T1
C16
R1
D2
C1
U1
R4
D3
60
C6
D10
C7
C5
D1
L
C2
N
52
54
U5B
VCC
R15
R16
GND
72
OUTLET
92
90
N
L
T2
70
D6
R9
R5
R7
C9
CON2
S1
S2
B
A
A
C
KEY
GND
VCC
R19
R20
R17
R18
C11
R14
64
C8
U4
WATER
KEY
R13
C10
VCC
R10
U2
R8
R21
Q1
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R12
U3
R11
R22
88
Q2
16
M

Fig-3

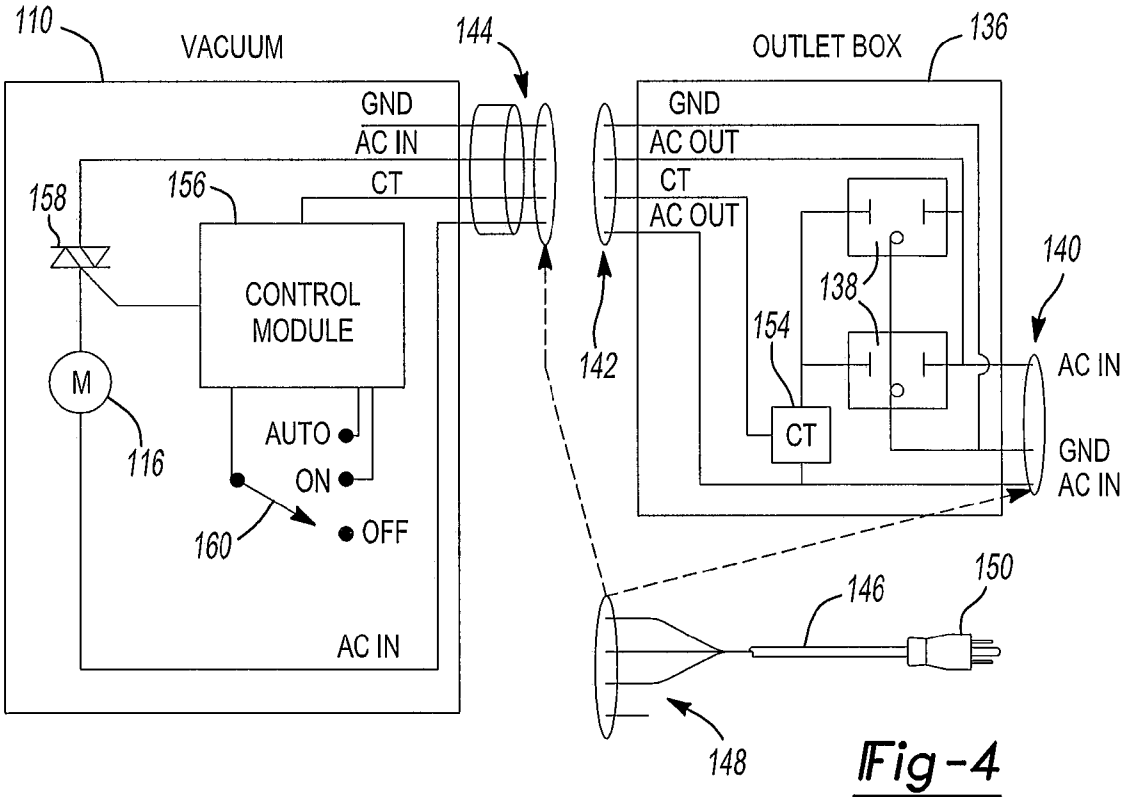

110
VACUUM
144
OUTLET BOX
136
GND
AC IN
CT
GND
AC OUT
CT
AC OUT
158
156
CONTROL MODULE
M
116
AUTO
ON
OFF
160
142
138
140
154
CT
AC IN
GND
AC IN
146
150
148
AC IN

Fig-4

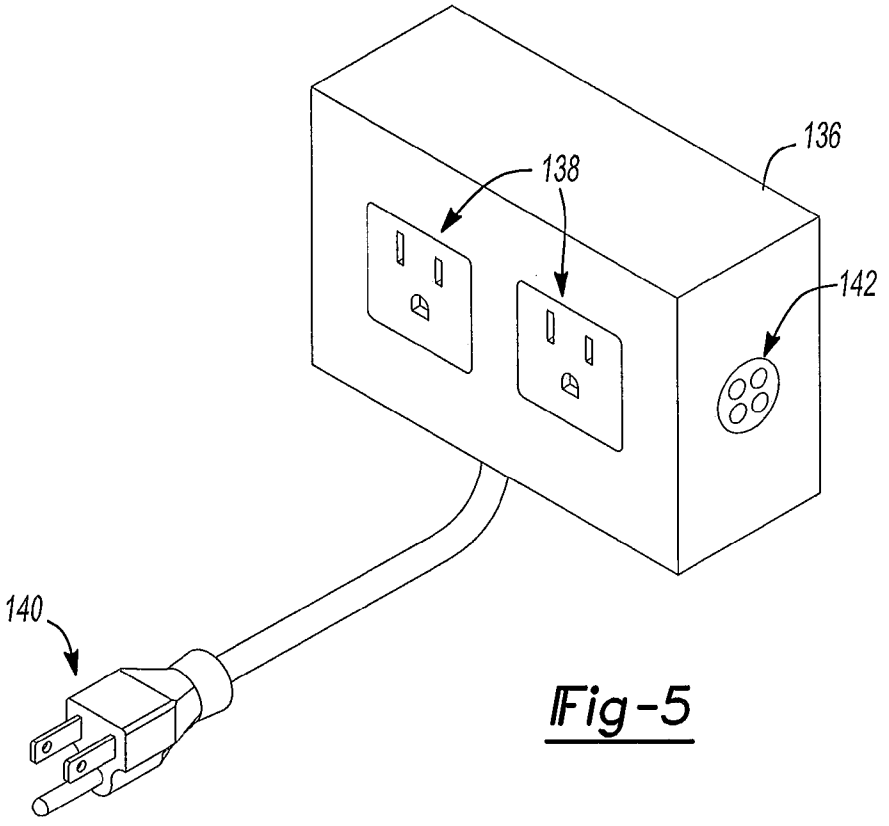

136
138
142
140

Fig-5

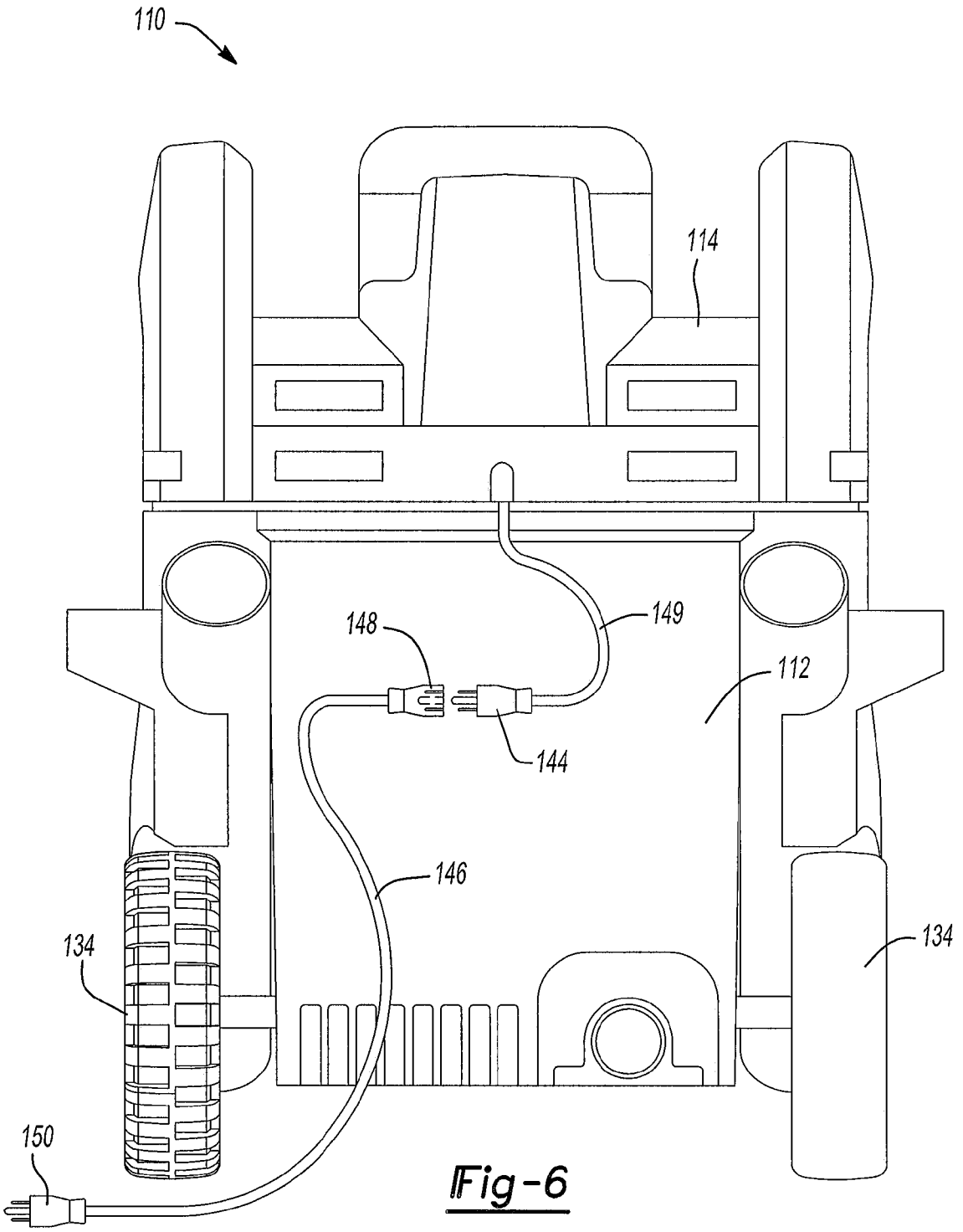


Fig-6

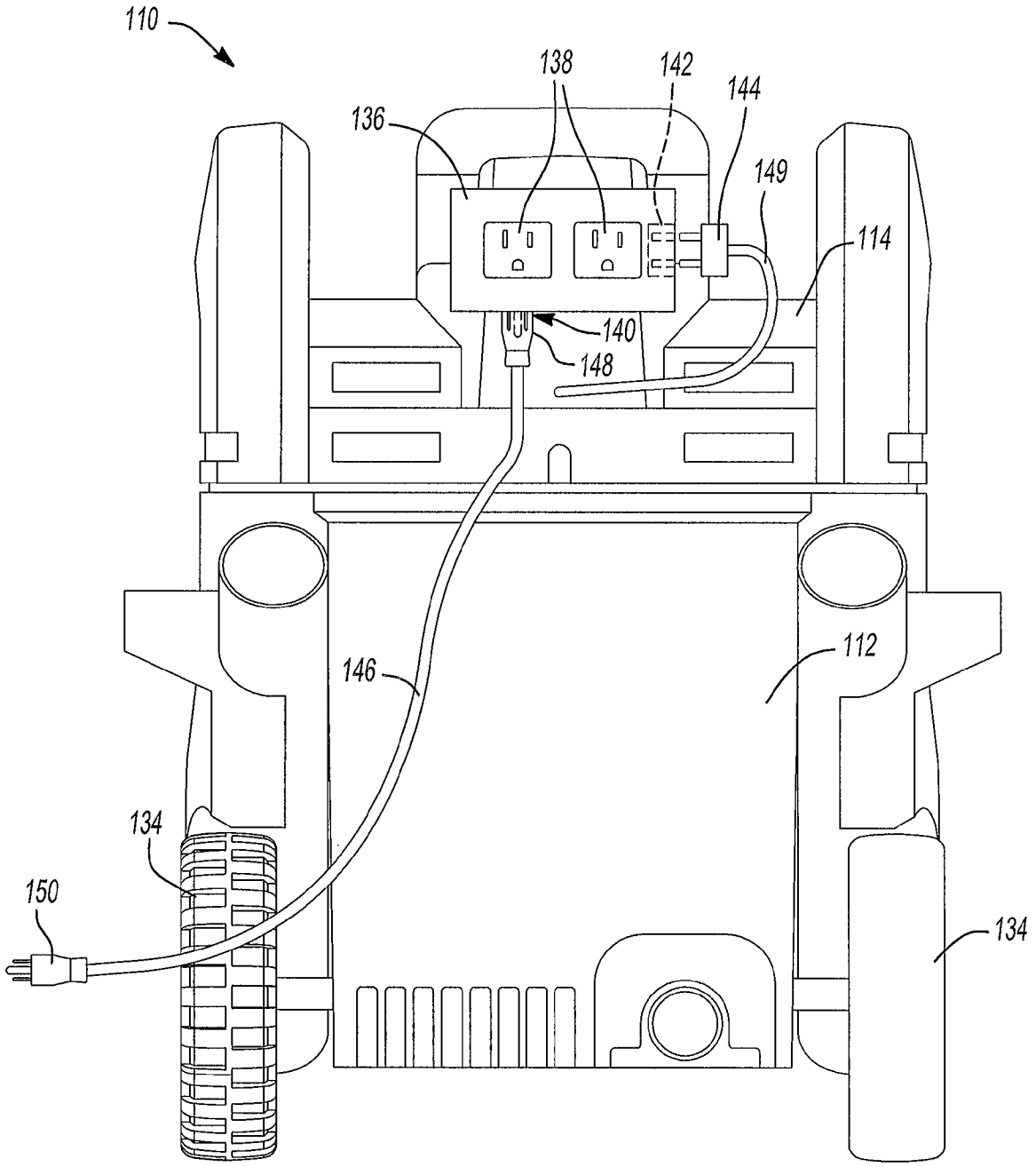


Fig-7

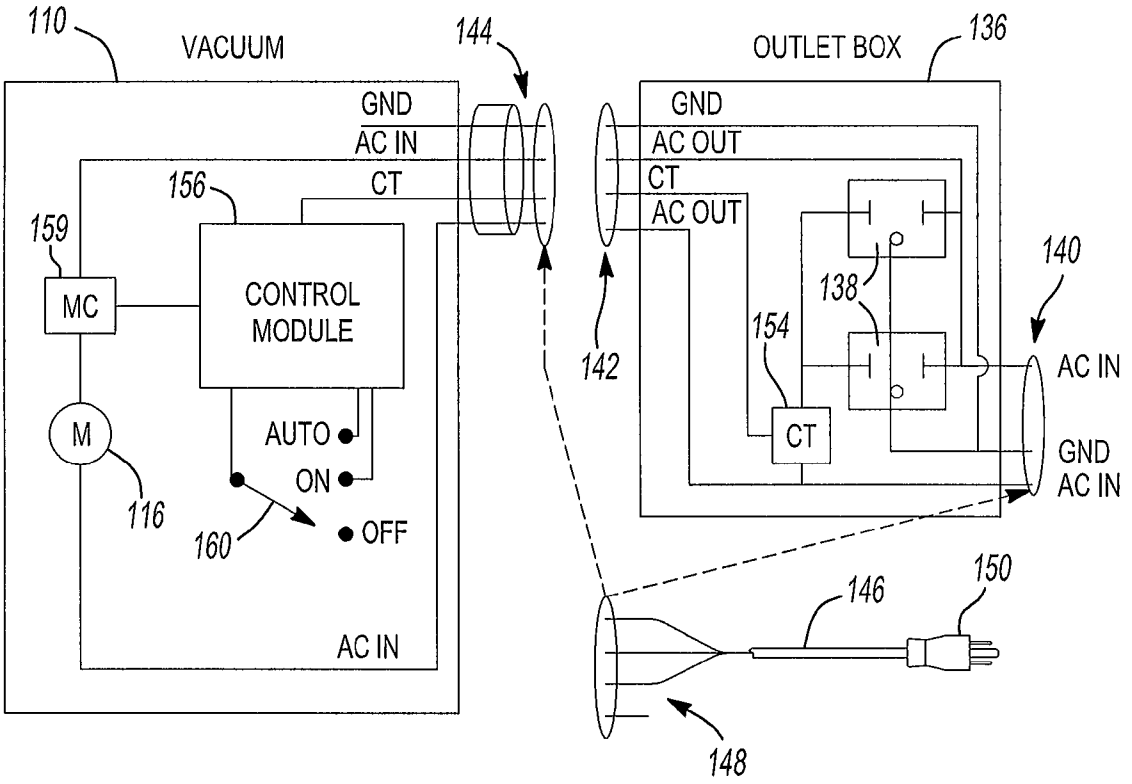
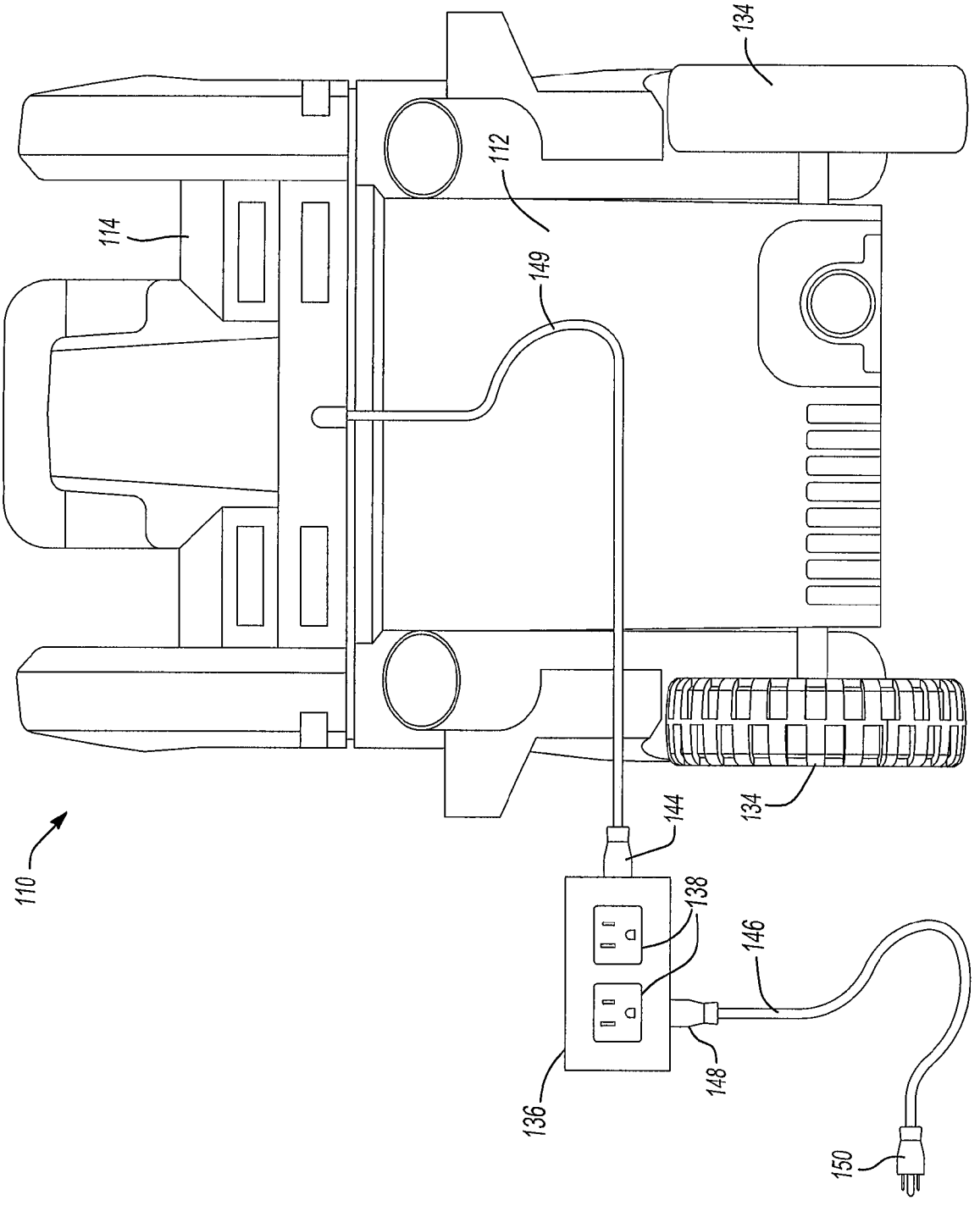

110
VACUUM
144
GND
AC IN
CT
156
159
MC
CONTROL MODULE
M
116
AUTO
ON
OFF
160
AC IN
OUTLET BOX
136
GND
AC OUT
CT
AC OUT
142
138
140
154
CT
AC IN
GND
AC IN
146
150
148

Fig-8

Fig-9



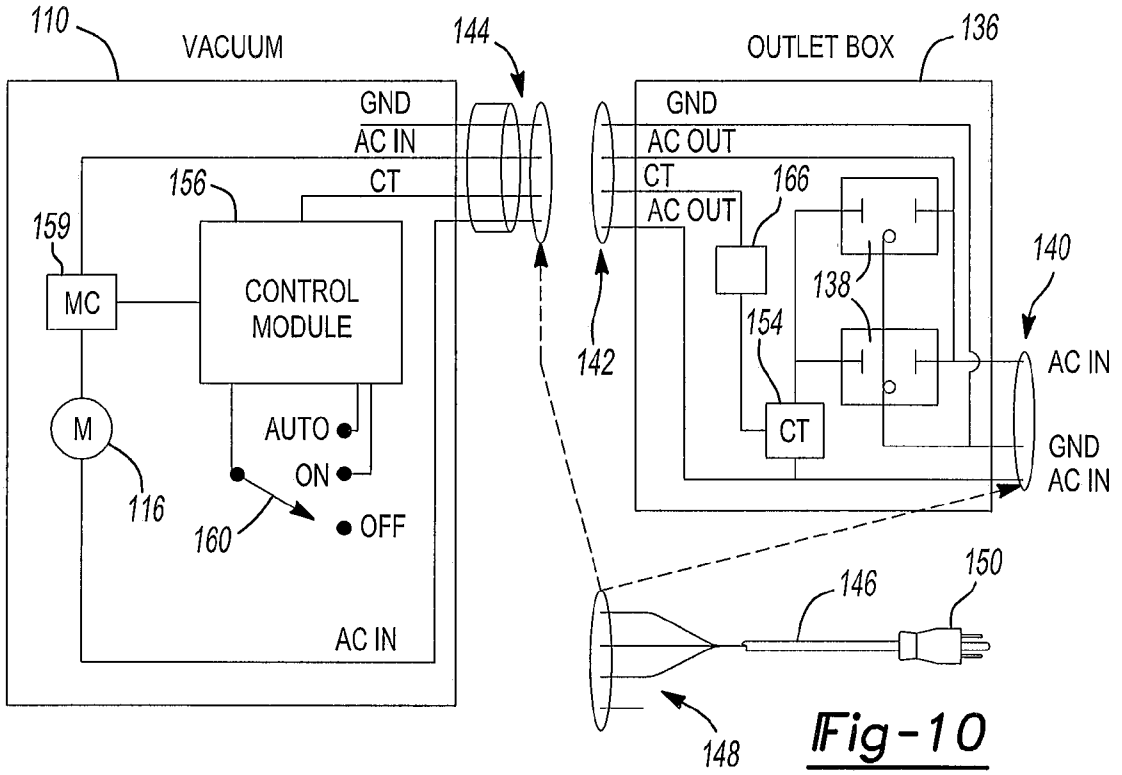
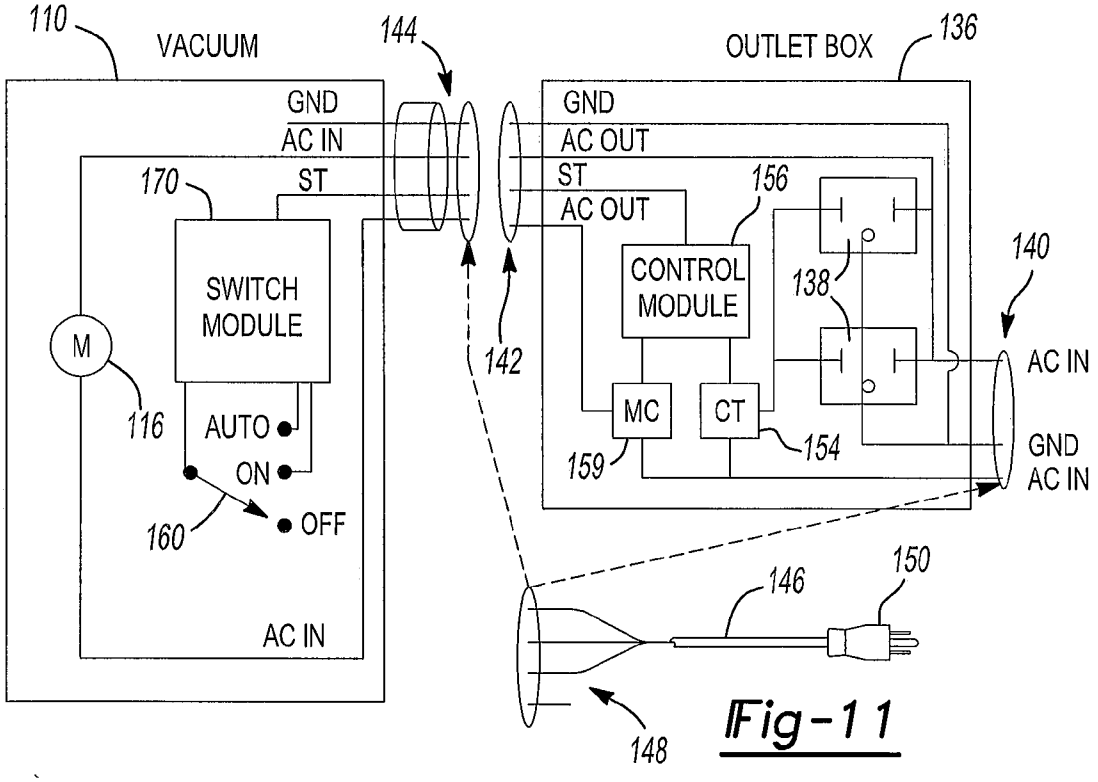

110
VACUUM
144
OUTLET BOX
136
GND
AC IN
CT
156
159
MC
CONTROL MODULE
M
116
AUTO
ON
OFF
160
AC IN
GND
AC OUT
CT
AC OUT
166
138
140
154
142
CT
AC IN
GND
AC IN
146
150
148

Fig-10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VACUUM
144
OUTLET BOX
136
GND
AC IN
ST
170
SWITCH MODULE
M
116
AUTO
ON
OFF
160
AC IN
GND
AC OUT
ST
AC OUT
156
CONTROL MODULE
138
140
142
MC
CT
159
154
AC IN
GND
AC IN
146
150
148

Fig-11

OUTLET BOX FOR POWER TOOL SENSE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 61/021,971, filed on Jan. 18, 2008. The entire disclosure of the above application is incorporated herein by reference.

FIELD

The present disclosure relates to electronics for vacuum cleaners, and more particularly to an electronic power tool sense system for a vacuum.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

Conventional industrial shop vacuums are employed for both wet and dry usage. However, the electronics for conventional industrial shop vacuums can be primitive in design.

Conventional vacuums may include a container and a cover that closes the container. The cover may support a vacuum motor with a power cord. The power cord may include a power plug that may be connected to a power source. When powered up, the vacuum motor may rotate a suction fan, thereby drawing air from the container. A flexible hose may be mounted on an inlet to the vacuum for drawing debris (including solids, liquids, and gases) into the container.

Conventional vacuums may also include an onboard power outlet that may be electrically connected to the power cord of the vacuum. The onboard power outlet may receive a power plug of a power tool. Accordingly, a user may plug the power plug of the vacuum motor into a power outlet in a wall (or some other power source), and plug the power plug of the power tool into the onboard power outlet of the vacuum. In this way, the vacuum motor and the power tool may be driven with only a single power cord (i.e., the power cord of the vacuum) being physically connected to a power source.

While the conventional onboard power outlets are generally thought to provide acceptable performance, they are not without shortcomings.

SUMMARY

The present disclosure provides a vacuum electronic power tool sense system for sensing the operation of a power tool that is plugged into a power outlet. The power outlet can be provided in a separate outlet box from the vacuum housing. The outlet box is electrically connected to a vacuum source of the vacuum. A control module can operate the vacuum source in response to a sensed operation of the power tool plugged into the power outlet of the separate power outlet box to provide simultaneous operation of the power tool and vacuum in order to facilitate user clean-up of messes generated by use of the power tool.

A vacuum system according to the present disclosure includes a vacuum having a housing and a vacuum source disposed in the housing. There is an outlet box separate from the vacuum and electrically connected to the vacuum source. The system includes a power tool sensing system for sensing operation of a power tool plugged into the outlet box. The system also includes a control module for operating the vacuum source in response to a sensed operation of the power tool.

A vacuum according to the present disclosure includes a housing and a vacuum source disposed in the housing and including a motor. An outlet is electrically connected to the vacuum source. A power tool sensing system senses operation of a power tool plugged into the outlet. A control circuit operates the vacuum source in response to a sensed operation of the power tool. The control circuit includes a triac that provides electricity to the motor of the vacuum source and an opto-coupler that provides an activation voltage to the triac. The triac provides electricity to the motor when receiving the activation voltage from the opto-coupler.

A vacuum system according to the present disclosure includes a vacuum having a housing and a vacuum source including a motor. There is an outlet box separate from the vacuum and electrically connected to the vacuum source. The outlet box includes an outlet for supplying electrical power and a power tool sensing system for sensing operation of a power tool plugged into the outlet. The system also includes a control module for operating the vacuum source in response to a sensed operation of the power tool provided by the power tool sensing system.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

FIG. **1** is a perspective view of an example industrial shop vacuum according to the principles of the present disclosure;

FIG. **2** is a schematic diagram of an example industrial shop vacuum according to the principles of the present disclosure;

FIG. **3** is a schematic circuit diagram for the electronic controls according to the principles of the present disclosure;

FIG. **4** is a schematic circuit diagram for the electronics for an outlet box for use with a vacuum according to the principles of the present disclosure;

FIG. **5** is a perspective view of an outlet box for use with a vacuum according to the principles of the present disclosure;

FIG. **6** is a rear plan view of a vacuum with a modified cordset according to the principles of the present disclosure;

FIG. **7** is a rear plan view of a vacuum with a modified cordset connected to an outlet box according to the principles of the present disclosure;

FIG. **8** is a schematic circuit diagram for alternative electronics for an outlet box for use with a vacuum according to the principles of the present disclosure;

FIG. **9** is a rear plan view of a vacuum with a power strip according to the principles of the present disclosure;

FIG. **10** is a schematic circuit diagram for alternative electronics for an outlet box for use with a vacuum according to the principles of the present disclosure; and

FIG. **11** is a schematic circuit diagram for alternative electronics for an outlet box for use with a vacuum according to the principles of the present disclosure.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is not intended to limit the present disclosure, application,

or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. As used herein, the term "module" may refer to an application-specific integrated circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and memory that executes one or more software or firmware programs, a combinational logic circuit, or other suitable components that provide the described functionality.

With reference to FIGS. **1** and **2**, an example vacuum **10**, according to the principles of the present disclosure, will now be described. The vacuum **10** may include a canister **12** and a vacuum head **14** that closes the canister **12**. The vacuum head **14** may support a drive motor **16**. The drive motor **16** may support a suction fan **18**, which may be provided in a fan chamber **20** of the vacuum head **14**. The fan chamber **20** may be in fluid communication with an exhaust port **22** and an intake port **24**. The intake port **24** may be covered by a filter assembly **26** situated in a filter housing **28** of vacuum head **14**.

Motor **16**, when powered up, may rotate the suction fan **18** to draw air into the suction inlet opening **30** and through the canister **12**, through the filter assembly **26**, through the intake port **24** and into the fan chamber **20**. The suction fan **18** may push the air in the fan chamber **20** through the exhaust port **22** and out of the vacuum **10**. A hose **32** can be attached to the inlet opening **30**. The canister **12** can be supported by wheels **34**. The wheels **34** may include caster wheels, wheels supported by an axle, or both.

Vacuum **10** may be operated in a variety of modes. In an "Off" mode, operation of motor **16** is prohibited. In an "On" mode, motor **16** is operated. In an "Auto" or "Sensing" mode (hereinafter the "Auto" mode), operation of motor **16** automatically commences upon the activation of a power tool, as described below. Vacuum **10** can be switched between the various operating modes by a switch, knob, or the like by way of non-limiting example.

With reference to FIG. **3**, a schematic diagram of the electronics **50** utilized to operate the vacuum **10** will now be described. The electronics **50** generally include a power cord **52** extending from the vacuum and adapted for connection with an AC power source **54**. In particular, the power cord **52** can include a plug **56** having a two-prong or three-prong connection as is known in the art, as is shown in FIG. **2**. The power cord **52** is connected to a power source circuit **60**. An electrical isolation circuit **62** is provided in communication with the power source circuit **60** for providing a low voltage output VCC, as will be described in greater detail herein. A controller **64** (for example, a microcontroller) is provided in communication with the electrical isolation circuit **62** for receiving a low voltage supply VCC therefrom. The microcontroller **64** provides control signals to a vacuum circuit **68**.

A power tool sense circuit **70** is provided in communication with the microcontroller **64** for providing a signal to the microcontroller **64** regarding operation of a power tool that is plugged into an outlet **72** that can be disposed on the vacuum **10**. The outlet **72** can be connected to the power cord **52** as indicated by nodes L, N.

The microcontroller **64** can provide a control signal to the vacuum circuit **68**. The vacuum circuit **68** is provided with an opto-coupler **86** which receives a low voltage signal from the microcontroller **64**. The opto-coupler **86** can provide an activation voltage to a triac **88** which is held active by the voltage supplied by the opto-coupler **86** to provide electricity to the vacuum motor **16**. The opto-coupler **86** requires only a low power input for holding the triac **88** active.

Microcontroller **64** can provide the low voltage signal to opto-coupler **86** to provide an activation voltage to triac **88** in response to operation of vacuum **10** in the "On" mode. Microcontroller **64** can also provide the low voltage signal to opto-coupler **86** to provide an activation voltage to triac **88** in response to operation of vacuum **10** in the "Auto" mode when operation of a power tool connected to outlet **72** is sensed. In the "Off" mode, microcontroller **64** does not provide the low voltage signal to opto-coupler **86**.

The power tool sense circuit **70** is provided with a current transformer **90** that senses current passing through an electrical connection to the power outlet **72** that supplies power to a power tool that can be plugged into the power outlet **72**. The current transformer **90** provides a signal to the microcontroller **64** indicative of the activation state of a power tool plugged into the outlet **72**. In response to the power tool sense circuit **70**, the microcontroller **64** can automatically activate the vacuum motor **16** for driving the vacuum source. Thus, when a power tool is plugged into the outlet **72** and is activated by a user, the vacuum motor **16** can be activated to assist in vacuuming debris that is created by the use of the power tool. The microcontroller **64** can delay deactivation of the vacuum motor **16** after the power tool is deactivated, to allow for the vacuum **10** to collect debris for a predetermined period of time after the power tool is deactivated.

The electrical isolation circuit **62** is provided to eliminate shock hazard. Three components provide isolation including the power supply transformer **100** as well as the current transformer **90** and the opto-coupler **86**. The power supply transformer **100** provides a reduced voltage output from the power source **54**. By way of example, a five volt reduced power supply VCC can be provided by the electrical isolation circuit **62** from the AC line voltage source **54**. The power source circuit **60** previous to the transformer **100** is the control circuit for the switching supply. The transformer provides isolation and is part of the switching supply. The 5V regulator takes the isolated control circuit output and reduces it to +5V regulated. The low voltage power supply VCC is utilized by the microcontroller **64** for providing signals to the opto-coupler **86** of vacuum circuit **68**. The low voltage power supply VCC can also be used to supply power to a water sense circuit, a filter cleaning circuit, and/or ratio switch circuits by way of non-limiting example.

With reference to FIGS. **6**, **7**, and **9**, an alternative vacuum **110**, according to the principles of the present disclosure, will now be described. The vacuum **110** may include a canister **112** and a vacuum head **114** that closes the canister **112**. The vacuum head may support a drive motor **116** (FIG. **4**). The drive motor **116** may support a suction fan, which may be provided in a fan chamber of the vacuum head **114**. The fan chamber may be in fluid communication with an exhaust port and an intake port. The intake port may be covered by a filter assembly situated in a filter housing of the vacuum head **114**.

The motor **116**, when powered up, may rotate the suction fan to draw air into the suction inlet opening and through the canister **112**, through the filter assembly, through the intake port and into the fan chamber. The suction fan may push the air in the fan chamber through the exhaust port and out of the vacuum **110**. A hose can be attached to the inlet opening. The canister **112** may be supported by wheels **134**. The wheels **134** can include caster wheels, wheels supported by an axle, or both.

The vacuum **110** can be utilized in conjunction with an auxiliary outlet box **136**. As shown in FIGS. **7** and **9**, vacuum **110** can be connected to outlet box **136** and receive electrical power therefrom. Alternatively, as shown in FIG. **6**, vacuum **110** can be connected to a power source without utilizing outlet box **136**. Outlet box **136** can include one or more plug outlets **138** and can include a first connector **140** which can be coupled to a power supply. Outlet box **136** can provide power

to a power tool connected to outlets **138** and to vacuum **110** when connected thereto, as described below.

Vacuum **110** can include multiple modes of operation, such as that discussed above with reference to vacuum **10**. For example, vacuum **110** can include an "On" mode wherein motor **116** is operated. Vacuum **110** can also include an "Auto" or "Sensing" mode (hereinafter the "Auto" mode) wherein operation of motor **116** is commenced in response to sensing activation of a power tool connected to outlet **138** of outlet box **136**. Vacuum **110** can also include an "Off" mode wherein activation of motor **116** is prevented. Vacuum **110** can be switched between the various operating modes by a switch, knob, or the like by way of non-limiting example.

With reference to FIG. **4**, a schematic diagram of the electronics utilized to operate the vacuum **110** will now be described. Auxiliary outlet box **136** is provided for electrical connection to the vacuum **110**. The auxiliary outlet box **136** can include one or more plug outlets **138** and can include first connector **140** and a second connector **142**. The first connector **140** is illustrated as a male connector and can include a pair of "AC In" connectors and a ground connector. The second connector **142** is illustrated as a female connector and can include a pair of "AC Out" connectors, a ground connector, and a control signal connector CT. The second connector **142** is adapted to be connected to a male connector **144** of the vacuum **110**, the male connector **144** having corresponding connectors to the second connector **142**, namely a pair of "AC In" connectors, a ground connector, and a control signal connector CT.

A power cord **146** can be used to supply AC power to vacuum **110** or outlet box **136**. Power cord **146** can have a female connector **148** at a first end adapted to be connected to either the male connector **144** of the vacuum **110** or the male connector **140** of the outlet box **136**. The male connector **144** can be provided on the vacuum housing or on a short cable **149**. The female connector **148** includes a pair of AC connectors, a ground connector, and a fourth dummy receptor that can receive the control signal connector CT of male connector **144** of the vacuum **110**. A second end of the power cord **146** includes a plug **150** adapted for connection with an AC power source. In particular, the plug **150** can include a three-prong connection as is known in the art.

The outlet box **136** can be mounted to any surface of the vacuum **110**, such as shown in FIG. **7**, or can be used without being mounted on the vacuum **110**, such as shown in FIG. **9**. The outlet box **136** can also be used as an outlet strip without the vacuum **110**, as shown in FIG. **5**.

A power tool sense circuit **154** is provided in communication with one or more of the outlets **138** and is connectable to a control module **156** for providing a signal to the control module **156** regarding operation of a power tool that is plugged into an outlet **138** on the outlet box **136**. The outlet **138** can be connected to the power cord **146** as indicated by nodes AC In, GND, AC In.

The power tool sense circuit **154** can be provided with a current transformer that senses current passing through an electrical connection to the power outlets **138** that supplies power to a power tool that can be plugged into the power outlets **138**. The power tool sense circuit **154** provides a signal to the control module **156** indicative to the activation state of a power tool plugged into the outlets **138**. In response to the power tool sense circuit **154**, the control module **156** can automatically activate the vacuum motor **116** for driving the vacuum source. In particular, the control module **156** can provide a control signal to a triac **158** to hold the triac **158** active to provide electricity to the vacuum motor **116**. Alternatively, as illustrated in FIG. **8**, the control module **156** can provide a control signal to a motor control module **159** to provide electricity to the vacuum motor **116**. The power tool sense circuit **154** and control module **156** can be similar to the system described with reference to FIG. **3** with the current sense system in the outlet box **136** and the controller in the vacuum **110**. The control module can be a microcontroller or dedicated control circuit. Thus, when a power tool is plugged into the outlets **138** and is activated by a user, the vacuum motor **116** can be activated to assist in vacuuming debris that is created by the use of the power tool. The control module **156** can delay deactivation of the vacuum motor **116** after the power tool is deactivated, to allow for the vacuum **110** to collect debris for a predetermined period of time after the power tool is deactivated.

In some exemplary configurations, as shown in FIG. **10**, the outlet box **136** can also be provided with smart electronics **166** (either a module, a controller, or dedicated circuit) to process the power tool sense signal and send a vacuum "On" or vacuum "Off" signal to the electronics in vacuum **110**. For example, the power tool sense signal could be converted to DC, rectified, and filtered. The electronics in the vacuum **110** receive this processed signal and act accordingly depending on the operational mode of vacuum **110** as determined by a control switch **160** position ("Off" mode, "On" mode, "Auto" mode). This system may be less noise sensitive than sending an analog CT signal.

As yet another alternative, as shown in FIG. **11**, the control electronics can all be provided in the outlet box **136**. The outlet box **136** can include control module **156** and motor control module **159**. Motor control module **159** can include a triac. Vacuum **110** can include a switch module **170** connected to switch **160**. Switch module **170** can provide a switch signal ST to control module **156** indicative of the desired operational mode of vacuum **110** provided by control switch **160** position. Switch signal ST can be switch information provided directly through a high or low signal with one wire for each micro switch or through serial communication. Control module **156** provides signals to motor control module **159** to operate motor **116** based on the switch signal ST and the power tool sense signal provided by CT **154**, as described above. The electronics within the outlet box **136** can directly control power to the vacuum motor **116**. The advantage of this setup is reduced electronics in the vacuum **110** and the power tool sense signal is fairly noise insensitive. The control of the motor control module **159** within the outlet box **136** provides an electrical connection to the vacuum motor **116**.

A control switch **160** is provided for controlling the vacuum **110** in "ON", "OFF" and "AUTO" modes of operation. In the "ON" mode, the vacuum motor is turned on. In the "OFF" mode, the vacuum motor is turned off. In the "AUTO" mode, the vacuum motor is activated in response to a signal from the power tool sense circuit **154**.

In this example embodiment, the outlet box **136** may include two power outlets **138**. Alternative embodiments may implement more or less than two power outlets **138**. Additionally, it should be appreciated that while male and female connectors are shown and described with reference to specific connectors, the use of male and female connectors for the various connectors can be changed from that shown. Moreover, in some configurations the outlet box **136** may be limited in operation such that outlets **138** are not operable to supply electricity to a power tool connected thereto when the vacuum **110** is in any mode other than the "Auto" mode. Furthermore, while power tool sense signal CT and switch signal ST are shown as being provided through a single line/wire, multiple lines/wires may be utilized. Additionally, in some configurations, it may be possible to connect the first

connector **140** of the outlet box **136** directly to a power source without the use of power cord **146**.

Thus, the foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. A vacuum system comprising:

a vacuum having a housing and a vacuum source disposed in said housing;

an outlet box separate from said vacuum and electrically connected to said vacuum;

a power tool sensing system for sensing operation of a power tool plugged into said outlet box;

a control module for operating said vacuum source in response to a sensed operation of said power tool, wherein said vacuum includes a first connector having at least four connections, said outlet box includes a second connector having at least four connections and adapted to engage said first connector to electrically connect said outlet box to said vacuum; and

wherein said outlet box includes a third connector electrically connected to said second connector, and further comprising a power cord including a fourth connector having at least four connections, said power cord adapted to be connected to either of said first and third connectors to supply electrical power to either of said vacuum and said outlet box, and said power cord including a fifth connector adapted to connect to a power source.

2. A vacuum system comprising:

a vacuum having a housing and a vacuum source disposed in said housing;

an outlet box separate from said vacuum and electrically connected to said vacuum;

a power tool sensing system for sensing operation of a power tool plugged into said outlet box; and

a control module for operating said vacuum source in response to a sensed operation of said power tool, wherein said outlet box includes a first connector and a second connector, said vacuum includes a third connector adapted to engage said first connector of said outlet box and electrically connect said outlet box to said vacuum, and further comprising a power cord having a fourth connector adapted to be connected to either of said second connector of said outlet box and said third connector of said vacuum to supply electrical power to either of said outlet box and said vacuum.

3. A vacuum comprising:

a housing;

a vacuum source disposed in said housing and including a motor;

an outlet electrically connected to said vacuum source;

a power tool sensing system for sensing operation of a power tool plugged into said outlet; and

a control circuit for operating said vacuum source in response to a sensed operation of said power tool, said control circuit including a triac that provides electricity to said motor of said vacuum source, and an opto-coupler that provides an activation voltage to said triac, said triac providing electricity to said motor when receiving said activation voltage from said opto-coupler.

4. The vacuum according to claim **3**, wherein said control module includes a microcontroller that receives a signal from said power tool sensing system and provides a signal to said opto-coupler to provide said activation voltage to said triac in response to said signal from said power tool sensing system.

5. The vacuum according to claim **4**, wherein said power tool sensing system includes a current transformer for sensing current passing through said outlet to said power tool.

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